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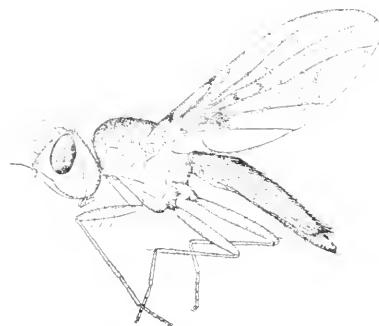
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

BULLETIN NO. 150

DECEMBER, 1922

Grasshoppers, Cutworms, and Other
Insect Pests of 1921-1922

Being the Nineteenth Report of the State Entomologist
of Montana



ADULT OF THE SUNFLOWER MAGGOT
Straussia longipennis Wied.

BY
R. A. COOLEY

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LETTER OF TRANSMITTAL

Bozeman, Montana, December 1, 1922.

To His Excellency,
Governor Joseph M. Dixon,
Helena, Montana.

My dear Sir:

I have the honor to hand you herewith my report as State Entomologist. For purposes of economy in printing no report was issued for last year (1921) and the present report covers the activities of this office for the years 1921 and 1922. It is our intention in the future to submit one report in each biennium.

The county insect pest law, enacted by the last legislative assembly, has proved of much value to us in conducting campaigns for the control of grasshoppers. It will serve equally well in meeting other emergency conditions as they arise. The State Entomologist's office, working jointly with county agents and aided by the county insect pest law, makes an effective system which already has resulted in much saving to the State.

Very respectfully,

R. A. COOLEY,
State Entomologist.

Nineteenth Report of the State Entomologist

GRASSHOPPERS

The spring of 1921 found practically all the agricultural counties of the State with a very serious grasshopper problem. In western Montana the egg beds of the warrior grasshopper (*Camnula pellucida* Seudder) extended over miles of territory through Sanders, Flathead, and Missoula counties, and upon hatching the young hoppers threatened the crops to the extent of complete destruction. The condition in the Centennial Valley in Beaverhead County was very much improved, due to an effective campaign in 1920, although some work there was again necessary.

Through those counties lying just east of the Continental Divide, particularly Gallatin, Jefferson, Lewis and Clark, Teton, and Pondera, the warrior hopper was again the chief species concerned, but in many sections through these counties the lesser-migratory grasshopper (*Melanoplus atlantis* Riley) was also present in very destructive numbers.

In central and eastern Montana, although the two-striped grasshopper (*Melanoplus bivittatus* Say) and the warrior grasshopper were present in considerable numbers, the great problem was with the lesser-migratory species. This species, which has manifested many of the characteristics of the old Rocky Mountain migratory locust (*Melanoplus spretus* Uhler) that caused such devastation of crops in the early days, was responsible for damage in practically every county in this part of the State and in most of the counties was present in such numbers that organized control campaigns against it were imperative. Although well worth while in point of crops saved, many of these campaigns were by no means extensive enough to prevent very serious losses. In many localities where a comparatively small number of farms lie surrounded by large areas of idle land, on which the lesser-migratory grasshopper is especially wont to breed, control measures were impracticable. In southeastern Montana, from Big Horn County east to Carter, damage to the range by swarms of grasshoppers constituted a great loss to the stockmen of that region. The native grasses were destroyed to such an extent that the feed on the range was so sparse

by late summer that conditions were similar to those that would have resulted from an extreme drought.

During 1921 twenty-six counties, as shown in Table I and figure 3, operated the county insect pest law and spent considerably over

TABLE I.—GRASSHOPPER CAMPAIGN, 1921—COUNTIES IN WHICH THE INSECT PEST LAW WAS OPERATED.

County	Law funds	Gen. fund etc.	Total	Tons bait used	Acreage treated	Estimated saving
Beaverhead	\$2,424.06		\$2,424.06	110	5,000	
Broadwater	685.54		685.54	18	1,800	
Cascade	2,794.00		2,794.00	58	13,900	\$28,000
Daniels	8,547.19		8,547.19	200	20,000	
Dawson	2,500.00	\$1,102.00	3,602.00	140.7	15,000	45,000
Fallon	1,933.40		1,933.40	62	7,000	50,000
Fergus	2,739.00		2,739.00	41	5,000	27,000
Flathead	6,000.00		6,000.00	269	19,333	
Gallatin	1,357.94		1,357.94	60	7,556	10,600
Golden Valley	2,238.24		2,238.24	100	5,000	
Jefferson	2,000.00		2,000.00	50	4,000	30,000
Judith Basin*						
Lincoln*						
McCone	3,735.00	1,206.12	4,941.72	80	8,000	
Madison	1,750.00		1,750.00	63.5	12,700	30,000
Missoula	3,300.00	4,210.00	7,510.00	180	60,000	
Musselshell	8,160.97		8,160.97	332	16,000	
Pondera*						
Prairie	2,351.31		2,351.31	182	3,150	
Roosevelt	3,000.00	12,000.00	15,000.00	590	36,433	183,622
Sanders	3,000.00	500.00	3,500.00	92	4,000	30,000
Stillwater	3,500.00		3,500.00	100	10,000	10,000
Teton	200.00		200.00	6	600	10,000
Valley	2,192.33		2,192.33	40	2,690	12,700
Wheatland	750.00		750.00	38	7,200	
Yellowstone	6,094.81		6,094.81	332	15,960	
Total	\$71,254.42	\$19,018.12	\$90,272.54	3,204.2	280,922	\$175,322

*County operated insect pest law but submitted no report.

TABLE II.—GRASSHOPPER CAMPAIGN, 1921—COUNTIES IN WHICH THE INSECT PEST LAW WAS NOT OPERATED.

County	Approx. money spent	Tons bait used	Acreage treated	Estimated saving
Blaine	\$215.79	6	600	\$1,800
Chouteau	516.25	20	1,875	10,000
Custer	700.00	40	3,000	
Hill	122.89	3	500	2,500
Lewis and Clark.....	409.65	20	1,000	3,500
Richland	819.37	20	3,320	9,990
Rosebud	819.00	30	2,500	
Treasure	800.00	30	2,500	
Total	\$1,162.95	169	15,305	27,790

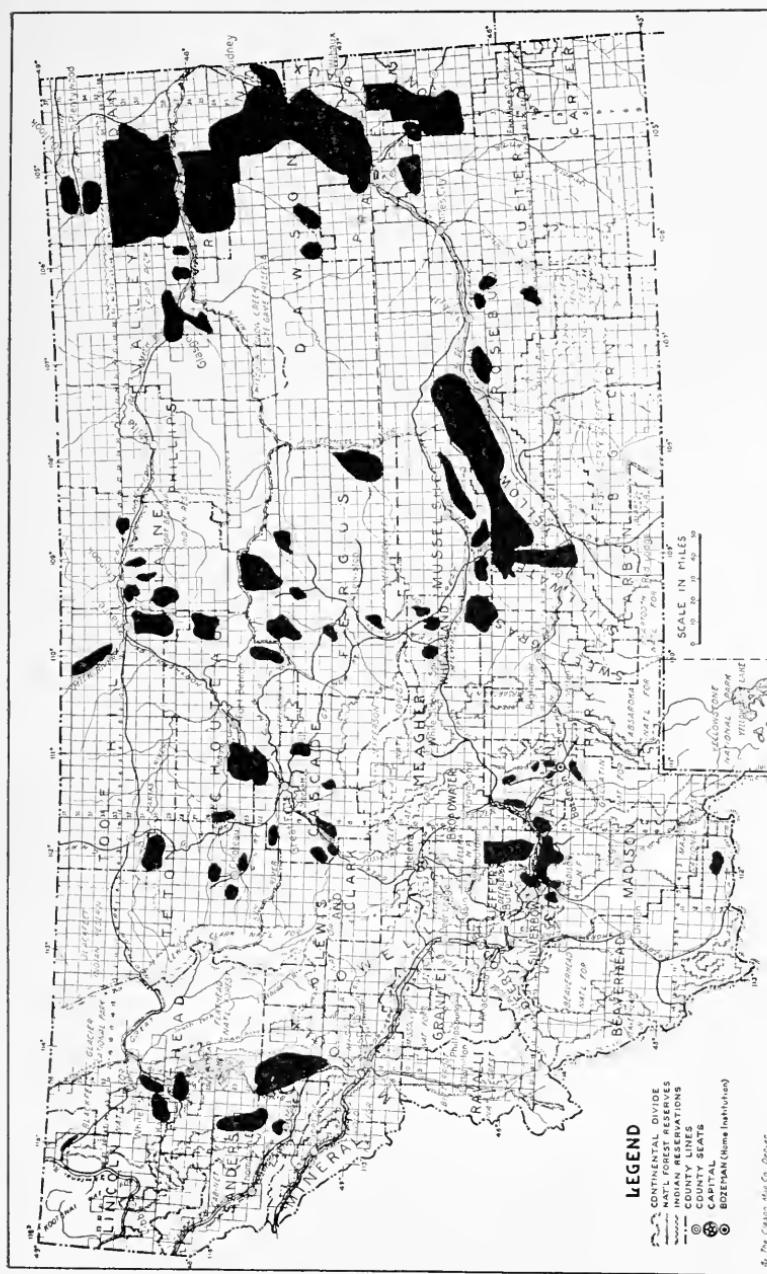


FIG. 1.—Dark areas indicate serious grasshopper infestations in Montana in 1921.

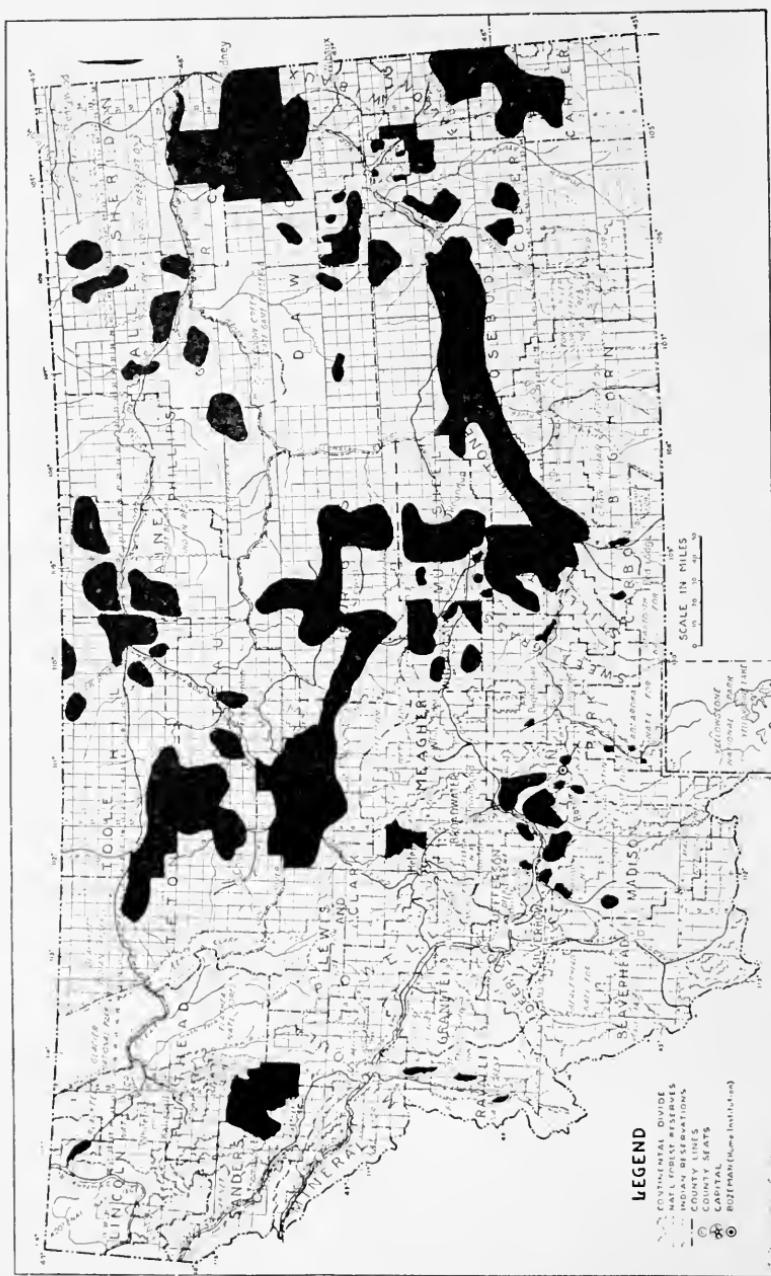


FIG. 2.—Dark areas indicate serious grasshopper infestations in Montana in 1922.

\$95,000 on grasshopper control. In western Montana these campaigns proved especially effective, so effective in fact that, assisted by the good work of the predaceous and parasitic enemies of the grasshoppers, little control work was necessary in 1922. In eastern Montana the saving to crops was enormous but so far as cutting down the hoppers to something like normal numbers was concerned, few areas where this was done can be cited. The principal reason for this difference in effectiveness in the eastern and western Montana campaigns lies in the habits of the different hoppers against which they were directed. As stated before, the species working in the western part of the State,

TABLE III.—GRASSHOPPER CAMPAIGN, 1922—COUNTIES IN WHICH THE INSECT PEST LAW WAS OPERATED.

County	Funds used	Tons bait used	Acreage treated	Estimated saving
Big Horn	\$5,400.00	142.5	23,750	
Carter	1,000.00	40	4,000	
Carbon	2,676.63	100	10,000	
Cascade	4,448.27	235.5	50,000	\$250,000
Daniels	3,700.00	150.5	12,000	120,000
Dawson		45.5	9,100	112,500
Fallon	2,647.02	40	8,000	40,000
Fergus	30,000.00	625.0	150,000	450,000
Flathead	2,200.00	40	5,336	
Gallatin	2,832.00	198	44,860	370,900
Garfield		120	10,000	
Glacier	589.50	20	3,000	
Golden Valley	10,011.51	380	18,500	
Judith Basin	4,638.65	220	20,000	
Liberty	3,028.77	80	8,000	
Lincoln	299.35	38	3,500	
Madison	725.00	16	4,500	10,500
McCone*				
Missoula	6,318.87	200	20,000	
Musselshell	3,362.69	131	12,000	
Park	76.50	3	150	
Phillips	3,950.00	65.5	9,200	18,400
Pondera	16,141.00	646	32,000	
Prairie	2,141.00	92.3	16,000	
Richland	1,000.00	66	10,000	20,000
Roosevelt	3,000.00	60	6,000	60,000
Sanders	750.00	15	1,500	7,000
Stillwater	3,000.00	150	20,000	30,000
Sweet Grass	2,200.00	94	4,000	
Teton	4,000.00	160	25,000	80,850
Toole	5,500.00	136	10,000	
Valley	4,000.00	80	13,000	12,000
Wheatland	15,000.00	225	45,000	
Yellowstone		225	25,000	
Total	\$153,696.76	4,880.8	633,396	\$1,582,150

*County operated insect pest law but submitted no report.

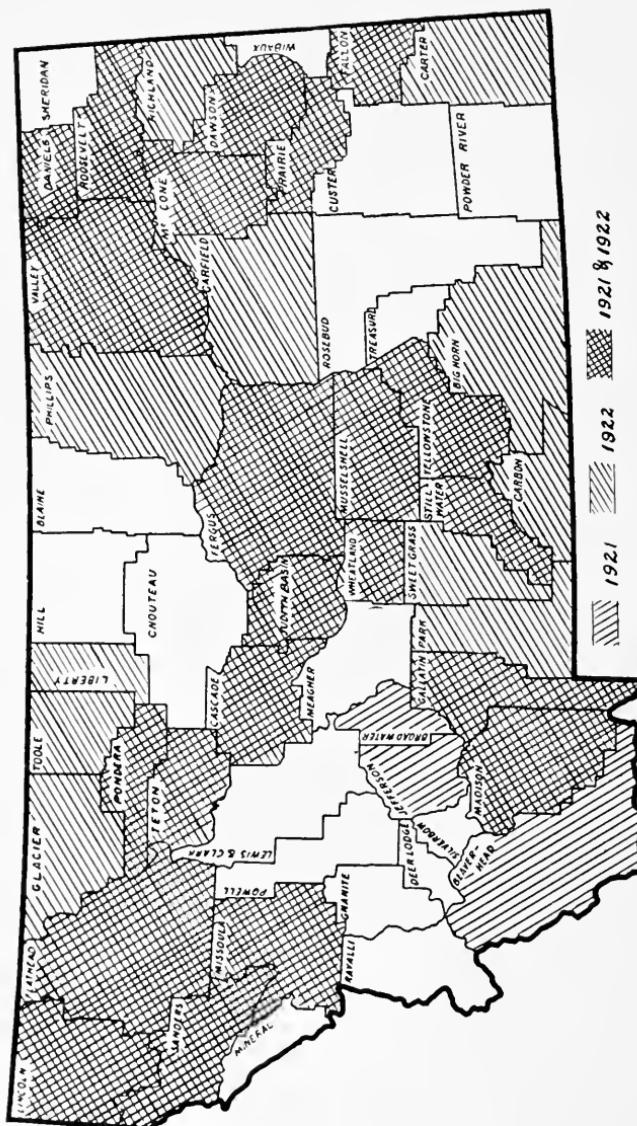


FIG. 3.—Counties that are shaded operated the insect pest law to support grasshopper campaigns in 1921 and 1922.

TABLE IV.—GRASSHOPPER CAMPAIGN, 1922—COUNTIES IN WHICH THE INSECT PEST LAW WAS NOT OPERATED

County	Approximate funds used	Tons bait used	Acreage treated	Estimated saving
Blaine	\$5,000.00	80.5	13,375	\$135,000
Broadwater		20	2,000	
Chouteau	19,000.00	400	64,400	400,000
Custer	3,200.00	55	9,160	
Hill	2,370.13	25	4,000	160,000
Jefferson		12.2	1,220	
Lewis and Clark.....	1,100.00	80	10,000	200,000
Ravalli	32.90	.7		
Rosebud		25	2,000	
Total	\$31,303.03	698.4	106,155	\$895,000

TABLE V.—SUMMARY OF GRASSHOPPER CAMPAIGNS, 1921 AND 1922

For Counties Which Operated Insect Pest Law		1921	1922
Number of counties		26	34
Funds expended (practically all for materials).....	\$80,272.54	\$153,696.76	
Tons of poisoned bran mash distributed.....	3,204.2	4,880.8	
Acres of land treated.....	280,922	633,396	
Estimated saving to crops*.....	\$475,322.00	\$1,582,150.00	
For Counties Which Did NOT Operate Insect Pest Law			
Number of counties		8	9
Funds expended (mostly for materials).....	\$4,462.95	\$31,303.03	
Tons of poisoned bran mash distributed.....	169	398.4	
Acres of land treated.....	15,305	106,155	
Estimated saving to crops*.....	\$27,790.00	\$895,000.00	
For All Counties			
Number of counties		34	43
Funds expended	\$94,735.59	\$184,999.79	
Tons of poisoned bran mash distributed.....	3,373.2	5,579.2	
Acres of land treated.....	296,227	739,551	
Estimated saving to crops*.....	\$503,112.00	\$2,477,150.00	

*See paragraph on "estimated crop saving."

and to some extent along the eastern slope, is primarily the warrior grasshopper. This species always shows a greater tendency to congregate for egg-laying than does any other common species in the State. Accordingly, it is easier to foresee outbreaks of the warrior grasshopper, because the egg-beds can be actually measured in a definite way and the extent of the infestations known pretty well beforehand. Furthermore, and for the same reason, when the hoppers begin to hatch they are at first very much bunched so that a small amount of poison used at the most propitious time will destroy the young in enormous numbers. On the other hand, the lesser-migratory grasshopper in the central and eastern sections does not deposit its eggs in well defined

areas. The eggs are spread over more country and consequently more expense and effort are attached to destroying the hoppers before they have spread into the crops and have started to cause damage. It is also very difficult to determine the likelihood of an outbreak of the lesser-migratory grasshopper with any degree of certainty as can be done with the warrior grasshopper. Then in addition, the species occurring in eastern Montana possesses a stronger migratory habit than the warrior grasshopper. Not only is the control of the migrating swarms on late crops very difficult but the migrations assist in the rapid spread of the hoppers over immense areas. Undoubtedly many of the infestations in the northern counties during the last two years originated from swarms which flew in from the southeast.

Accordingly, in 1922 the condition in western Montana was very much alleviated but east of the mountains the infested areas of the previous year had increased. North central Montana, especially the region drained by the Marias and Teton rivers, having been very dry in 1921, held a widespread infestation. The counties most concerned in this area were Pondera, Glacier, Toole, Liberty, Chouteau, and Teton. Farther east along the Great Northern Railway the infestations were worse than in 1921 except in northeastern Montana—Roosevelt, Daniels, and Sheridan counties—where fewer hoppers were present, although still numerous enough to make extensive campaigns necessary in two of these counties.

Increased infestations occurred in Cascade, Judith Basin, Fergus, Wheatland, Golden Valley, and Musselshell counties to the extent that many times as much money was spent in 1922 as in the previous year.

The rather sudden increase of the two-striped grasshopper (*Melanoplus bivittatus* Say) through the valley of the Yellowstone, coupled with the already serious infestations of the lesser-migratory grasshopper, made necessary organized campaigns in every county along the Yellowstone River from Sweet Grass County east to North Dakota.

Other counties not mentioned carried out extensive operations against the hoppers during the season, financed either privately or under the insect pest law. At the time this report is written information is lacking from many of the counties, but from the data at hand it appears that more than 700,000 acres of infested land in Montana were treated, with an estimated crop saving of well over \$2,500,000. This was done at a cost of approximately \$185,000 spent for materials.

ESTIMATED CROP SAVING IN GRASSHOPPER CAMPAIGN

It will be noted in the tabulations regarding the grasshopper campaigns of 1921 and 1922 that a monetary value was placed on crops saved in only eighteen counties for each year. This does not mean that the other counties, for which estimates of saving were not made, found the use of the poisoned bran mash of no benefit. On the contrary, in many of these counties the proportion of crop saved through fighting the grasshoppers was so great that to make anywhere near accurate estimates seemed impossible. In Flathead County, particularly in 1921, the opinion among the farmers and others qualified to judge was unanimous that had not the grasshoppers been destroyed very little crop would have been harvested. Although this was especially true in the western counties for which estimates were not given, it held true also for practically all the central and eastern Montana counties where, without any doubt, the proportion of crop saved was somewhat less. Then, too, no attempt was made to secure estimates on crops saved in any but counties employing county agents. Taking these things into consideration, the total money saved during these years through organized grasshopper campaigns was very much greater than actually shown by the tables given.

THE PALE WESTERN CUTWORM

Losses to wheat and other crops due to the pale western cutworm (*Porosagrotis orthogonia* Morr.) were not as severe in 1921 as in 1920, and during the past season (1922) the insect was of little consequence. Even though increased injury was suffered in some sections in 1921, it can be said for the entire area known to be infested that that year marked the first noticeable decrease in losses since this insect came into prominence as one of the most important pests of grain crops in Montana.

The following table shows a comparison, in so far as data were available, in percentages of total seeded areas destroyed from 1920 to 1922.

County	1920	1921	1922
Broadwater	23.9%	8.0%	0%
Cascade	35.0	30.0	0
Chouteau	30.7	10.0	0
Dawson .....	.....	10.0	0
Fallon .....	.....	12.0	0

County	1920	1921	1922
Glacier (eastern section) .....	.....	35.0	0
Hill	25.0	33.0	7
Jefferson	36.0	12.0	0
Liberty	47.1	50.0	3
Phillips	16.9	0.0	0
Prairie .....	.....	6.5	0
Teton	29.0	7.0	0
Toole	50.0	33.0	0
Yellowstone .....	.....	2.0-5.0	0

It will be seen that in 1921 marked reductions took place in Broadwater, Chouteau, Jefferson, Teton, and Toole counties and that in one county, Phillips, which had a loss of 16.9 per cent in 1920, there was no cutworm damage at all in 1921. This was also true of Valley and Roosevelt counties which suffered considerable loss in 1920 but none since that time. The counties in which the cutworms held their own in 1921 were Cascade and Glacier, although in Glacier County a definite estimate for 1920 was not secured. Increased losses were sustained in Hill and Liberty counties and several counties in the eastern part of the State, namely, Dawson, Fallon, Prairie, and Yellowstone, where large areas of corn and small grains were destroyed. In 1922 only a very small part of the area formerly infested suffered any damage and even in the two counties so affected, Hill and Liberty, the losses were very small when compared with those sustained the two preceding years.

The great decrease in the destructiveness of the pale western cutworm in 1922 is thought to have been due more than anything else to the heavy snowstorm which swept over most of the infested territory in northern Montana during the first part of September, 1921. The parent moths were thereby destroyed or at least prevented from depositing their eggs. Other reasons which may in part account for the decreases in both 1921 and 1922 are better moisture conditions during May and June than for several seasons past, greater prevalence of the natural enemies of the cutworms, and early irrigation of fields known to be infested. Thus the substantial reduction in Teton County in 1921 is believed to have been due to irrigation. Several fields on the Greenfield Bench which came under our observation showed heavy manifestations just prior to the time water was turned on them. Later reports showed these fields to have produced good

crops. In a few instances, notably in Jefferson County, fields on which winter wheat was destroyed by this insect in the spring of 1921 were reseeded to spring wheat with success, due mostly, it is believed, to the good growing conditions which prevailed. On the other hand, during the same year in Cascade County, one man is known to have seeded 240 acres three times without getting a crop, which is a typical example of the extreme destructiveness of this species of cutworm under conditions most favorable to it. That dry weather is the greatest contributing factor in outbreaks of this cutworm has been conspicuously demonstrated. In 1921 in the drought areas losses were maintained and in some instances increased over what they were in 1920 but where better moisture conditions existed losses decreased.

The season of 1922 saw a higher percentage of parasitism in the pale western cutworm than had been known in the State before. At the height of its destructiveness the lack of any parasitic enemies was very conspicuous but last summer as high as 42 per cent of the worms was destroyed by insect parasites. The mortality rate was increased to such an extent by disease and predaceous enemies that there is little possibility of this pest's causing material damage during the coming year.

The investigational work has not developed any direct method of destroying the worms. The main feature bearing on control brought out by Dr. W. C. Cook is that in some years early spring plowing (before May 1st) will prove an effective means of preventing damage. Briefly stated our control recommendations are based upon the following:

1. As a general practice, summer fallowed ground, plowed early and treated as recommended by the Montana Experiment Station, will be least affected by the pale western cutworm.

2. Good summer fallow which is not worked in any way between July 15th and September 15th will have a better chance than that which is worked during that time, due to the preference of the moths for freshly worked or "mulchy" ground in which to deposit their eggs.

3. In some years early spring plowing will prove as effective as summer fallow. This method must have restrictions placed upon it because it is believed that when the eggs fail to hatch in the fall, or, if hatched, the young worms fail to make growth in the fall, spring plowing before May 1st will destroy them. But when the eggs hatch early and the worms are of fair size when they go into hibernation,

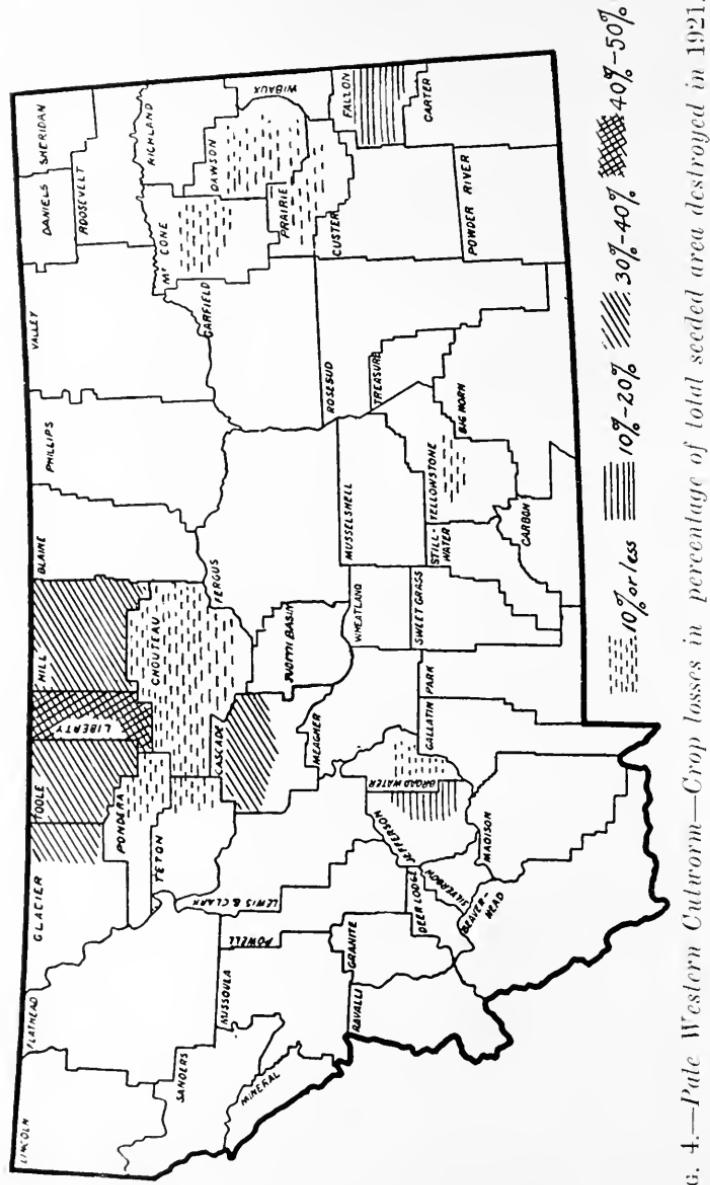


FIG. 4.—*Pale Western Cultivore—Crop losses in percentage of total sown area destroyed in 1921.*

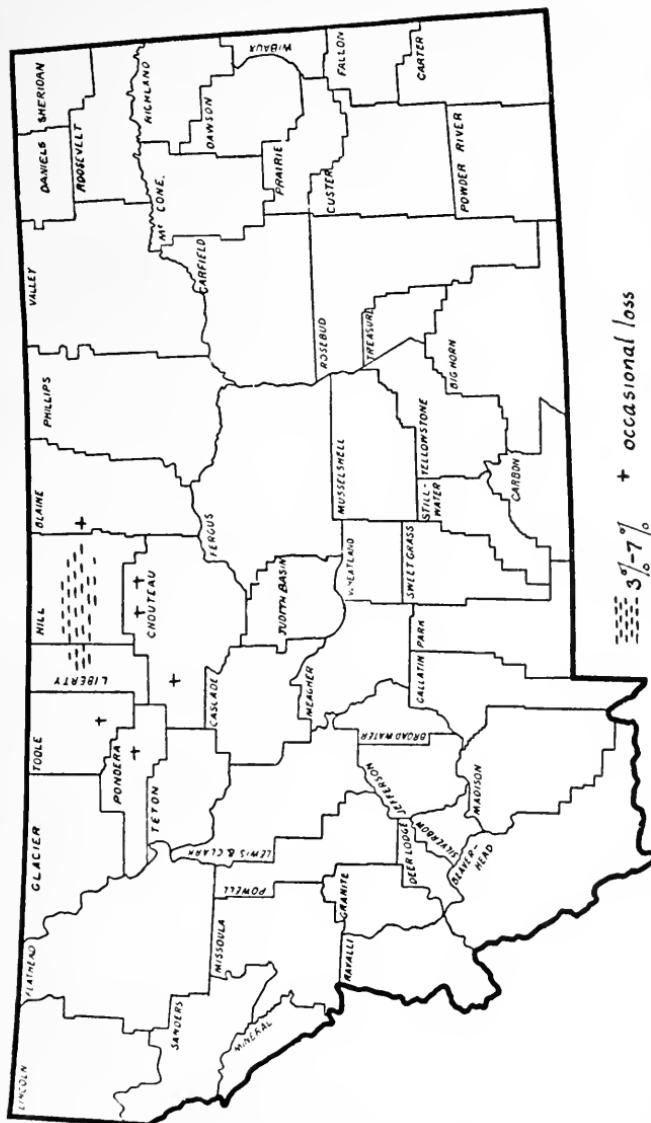


FIG. 5.—*Pale Western Cutworm*—Crop losses in percentage of total sown area destroyed in 1922. Note the great decrease in the destructiveness of this pest in comparison with 1921, figure 4.

they will be able to hold over in the ground from the time the spring plowing is done to the time when the young wheat is coming up to furnish something for them to feed upon. In other words, it is believed that the young worms can be starved out in the spring but that the older worms can not be.

4. No cultivation practices are of value where winter wheat is grown except when the wheat is seeded after September 15th.

5. Early irrigation will prove an effective means of preventing damage. Fields known to be infested which can be irrigated should have the water applied to them without delay.

THE FRUIT-TREE LEAF-ROLLER

The outbreak of the fruit-tree leaf-roller (*Archips argyrospila* Walker) in the Bitter Root Valley continued unabated during the past spring and summer. Several hundred acres of orchard were again totally stripped of foliage with the loss of thousands of boxes of apples, while injury of lesser importance extended to over a thousand acres. The pest is now established in four localities in sufficient numbers to cause noteworthy loss to the fruit crop, namely, at Stevensville, Victor, Corvallis, and Darby. Control measures carried out by a number of growers the past spring, while greatly reducing the injury, lacked the proper strength and thoroughness and were not sufficiently extensive to materially reduce the infestation.

During the past spring and summer (1922) tests were conducted in some of the worst infested orchards to determine the most effective and economical method of controlling this pest. Of five commercial brands of miscible oil sold on the market for leaf-roller control, only two proved sufficiently effective in these tests to warrant their use for this purpose. The strength required to secure an effective kill was also determined to be above that ordinarily recommended. The influence of high pressure, weather conditions, time of application, etc., on the results of spraying were satisfactorily worked out, as well as the life cycle for the insect in the Bitter Root Valley.

It was discovered that in the case of severe infestation, serious reduction in the fruit set and injury to the mature crop could be prevented only by the use of an effective miscible oil to destroy the eggs before they hatch. It was determined by these tests that in the case of mild infestation the pest could be effectively controlled by thorough applications of arsenate of lead, preferably with a spreader added.

The addition of sweet substances, such as syrup and molasses, was not found to increase the effectiveness of the arsenical sufficiently to warrant the added expense.

A very reassuring feature concerning the outbreak was the discovery of as high as 30 per cent reduction of the infestation through the beneficial work of the parasites, which are in no way injured by the artificial control measures. While this degree of parasitism is insufficient at present to materially reduce the numbers in the most heavily infested districts, it augers well for a natural control within a few years, inasmuch as the parasitism over this same area a year previous amounted to less than 10 per cent. The fruit growers are generally encouraged with the present outlook and are planning more extensive and thorough control measures for the coming year.

BLISTER MITE

This tiny form which attacks both foliage and fruit of the apple probably caused more injury and financial loss to the fruit growers of the Bitter Root Valley in 1921 than any other orchard pest. In fact, it is questionable whether in the aggregate the loss in culls and "C" grade fruit due to injury by the blister mite was not as great as that caused by all the other orchard pests combined. While this injury was more or less noticeable over the valley as a whole, especially to Wealthy, Rome Beauty, McIntosh, and Winter Banana, it was particularly severe in some of the orchards about Darby, in which the dormant or late dormant spraying with lime-sulphur had been omitted for some years.

The blister mite is not a difficult pest to control. Either lime-sulphur or miscible oil, carefully and timely applied, should give satisfactory results. On the whole, lime-sulphur is to be preferred, being less expensive and thoroughly dependable for this purpose. On account of the more general use of control measures against this pest in 1922, much less damage resulted than in the previous year.

THE GRANARY WEEVIL

Reports which came to us in September, 1921, regarding the serious losses due to the granary weevil (*Calendra granaria* L.) in southwestern Minnesota and South Dakota, where in some instances losses ranging up to one hundred and twenty-five dollars on a carload of wheat were experienced, caused us to make an investigation concerning this insect in Montana. Letters were sent to eight hundred grain

dealers and elevators in the State, asking if any dockage had occurred on Montana grain due to being reported "sample grade because of live weevil" or if they knew of the occurrence of the weevil in this State.

With but two exceptions the answers received were unanimous to the effect that no grain weevils existed here. Many grain dealers in business here for from fifteen to twenty years reported that to their knowledge no such infestations had ever occurred. However, two small infestations of this granary weevil accompanied by a less important species (*Laemophloeus pusillus* Schon.) were brought to our attention, one in northern Montana and the other in the southern part of the State. No dockage on Montana grain has been suffered and it would seem that the danger from weevil injury is small. The rigorous winters, coupled with preventive measures where small infestations do develop in some of the heated warehouses, etc., will no doubt take care of the situation.

GROWTH OF THE WORK OF THE STATE ENTOMOLOGIST

Until 1914 when county agricultural agents were first placed in several of the counties, although the state entomologist law had been in force for ten years there was no organization through which the office charged with the control of injurious insects could get its work done in an effective manner over the State generally. Until that time the State Entomologist had to depend very largely upon his own individual effort. As the appropriation for insect pest control was then very small the number of farmers and others reached, who really needed various kinds of information, was few. With the advent of the county agents, however, the machinery was set up at least in a portion of the counties through which the information at hand on the control of Montana pests could be disseminated with much better results. Over five thousand farmers cooperated with the county agents on grasshopper control alone during the summer of 1921 and many more than that number during the past season.

To bring about a reasonable degree of uniformity in the recommendations for the control of insect pests, loose-leaf record books containing the best information on the life histories and control of our common insect pests have been furnished the county agents. This book contains the experience of the entomologists of the Department of Entomology accumulated during a considerable number of years and the information is in harmony with the best practices followed in other parts of the country.

Other activities carried on in a large measure with or through the county agricultural agents are, briefly:

1. Issuance of emergency circulars and notices dealing with various insects which suddenly become injurious.
2. Demonstrations in the actual use of control measures.
3. Identification of insects to insure the use of the correct methods of control.
4. Making information available relative to sources and prices of supplies needed in combating various pests.
5. Familiarizing the agents with new developments concerning insects for which control measures are as yet inadequate.
6. General information needed in answering the many questions propounded to the agents and a general educational program aimed to promulgate a clearer understanding of insect life and behavior, not to mention the exposing of false ideas, superstitions, and worthless methods of insect control that are suggested.

In return, through our relations with the county agents we are kept aware of general insect conditions, the results of recommended control methods actually tried in the field, much information extremely valuable regarding the life histories and occurrence of various insects, injurious and beneficial, and reports of crop losses caused by injurious insect pests.

At the present time there are agents located in twenty-six counties. Although their work is officially confined to the counties by which they are employed, they nevertheless serve indirectly many surrounding counties that do not have the services of agents. Where a county agent organizes his farmers to combat some injurious pest and the results are very gratifying, neighboring counties at once begin to make use of similar methods. Agents who have had experience in the State have learned how our common pests are handled, thus making it possible for the State Entomologist to devote more time to counties where agents are not employed.

With the widening of the field of entomological work have come more pressing demands upon the State Entomologist's office, a correspondingly greater service to the State, and a greater interest in the study of one of the chief losses to crops in this region.

THE COUNTY INSECT PEST LAW

In order to deal successfully with a widespread outbreak of an injurious insect, concerted community action is necessary. This can

be secured only with proper organization, effective leadership, and adequate financial backing. Lacking any one of these things, a large outbreak can not be handled. To make it possible for counties to finance campaigns against various insect pests, the 1921 session of the legislature passed what is known as the insect pest law.

Under this law the county commissioners are empowered (1) to appoint a suitable person to supervise, under the direction of the State Entomologist, the control of any dangerous insect pest, and (2) to levy a general tax to be used in taking up county warrants issued in payment for necessary supplies. Although this law has been used in western Montana to partially support some fruit pest work, its greatest use has been in connection with outbreaks of grasshoppers. In 1921, twenty-six counties, and during the past season thirty-four counties, operated the law to control these pests. It has proved to be a very effective aid in fighting grasshoppers and has made possible many campaigns which resulted in immense saving of crops and which it would otherwise have been impossible to undertake. Several changes in the law, however, are advisable. Among these the two following are the most important.

Under the present law it is required that the county commissioners issue registered warrants on the "Insect Pest Fund" in payment for supplies. Then "the Board of County Commissioners shall determine the total amount of such warrants outstanding, and the succeeding year, shall levy a tax sufficient to retire and pay off all such outstanding warrants with accrued interest, which said tax shall be levied upon all the property in the county and shall not exceed one-half mill on each dollar of assessed valuation, and such tax when collected shall be credited to the 'Insect Pest Fund' and said warrants shall at once be called in and paid off and discharged." This makes it necessary for many counties which have sufficient money in the general fund to pay interest on registered warrants when this could very easily be avoided by transferring temporarily part of the general fund to the insect pest fund until the insect pest tax is collected.

Another change in the law has to do with an increase in the levy which the county commissioners are empowered to make. In many of the counties suffering under large insect outbreaks the assessed valuation is too low for the tax allowed to raise sufficient money to save the crops. It is recommended that the maximum levy be increased.

An idea of the work carried on under the county insect pest law since its passage can be had by an examination of the tables printed in this report regarding the grasshopper campaigns during 1921-22, and the map, figure 3, which shows the high proportion of counties which used the law during these years.

INSECT PESTS OF 1921

SNAILS (MOLLUSCA)

Gray Garden Snail (*Agriolimax agrestis* Linn.). This snail, sometimes referred to as the garden "slug," has continued to cause damage to tomatoes, lettuce, turnips, and other garden truck in a few localities.

MITES AND TICKS (ACARINA)

Pear-Leaf Blister-Mite (*Eriophyes pyri* Pgst.). See page 17.

THIRIPS (THYSANOPTERA)

Thrips (*Frankliniella tritici* Fitch). Damage to alfalfa seed and the honey flow by thrips continued this season but did not prove to be as serious as in 1920.

In some orchards of the Bitter Root Valley fully 25 per cent of the apples showed an unusual abundance of white blotches on the skin similar to injury attributed to the egg-laying punctures of a thrips by E. J. Newcomer, U. S. Bureau of Entomology, Yakima, Washington. This injury was particularly noticeable and annoying when attempting to select show fruit.

GRASSHOPPERS, CRICKETS (ORTHOPTERA)

Mormon Cricket (*Anabrus simplex* Hald.). The appearance of this insect in considerable numbers in Toole and Teton counties has been the cause of some conjecture among the farmers as to the damage which may occur next season. We have no record of this insect's occurrence in these localities before. It was reported by the farmers that the crickets came in from the northwest. This is a common insect in the mountains and valleys in some parts of the State but has never been observed so far east of the mountainous section before.

Warrior Grasshopper (*Camnula pellucida* Seudd.). This species was the chief one concerned in grasshopper outbreaks in Flathead, Sanders, Missoula, and Beaverhead counties. It was also present in great numbers through central Montana along with the two following species. (See general discussion on page 3.)

Lesser Migratory Locust (*Melanoplus atlantis* Riley). This species predominated in outbreaks through the eastern part of the State. (See general discussion, page 3.)

Two-Striped Grasshopper (*Melanoplus bivittatus* Say). This species occurred along with *M. atlantis* through central and eastern Montana but was of much less importance.

THE TRUE BUGS, PLANT LICE, ETC. (HEMIPTERA)

Bedbug (*Cimex lectularius* L.). This well-known pest continues to be a source of complaint in rural communities. Several instances of infestations in garages where night help was quartered came to our attention.

False Chinch Bug (*Nysius ericae* Schilling). The presence of this insect within the ears of corn in Prairie County in September led to the belief that it was the true chinch bug. No appreciable amount of damage was reported.

Elm Gall Louse (*Schizoneura americana* Riley). There was the usual number of complaints concerning injury by this insect from all parts of the State where the elm has become an important shade tree.

Cabbage Aphid (*Brevicoryne brassicae* L.). There was a noticeable increase in the abundance of this pest over 1920.

Green Apple Aphid (*Aphis pomi* DeGeer). These tiny green insects were in evidence in many orchards of the Bitter Root Valley but nowhere did they appear to be doing material damage.

Oyster-Shell Scale (*Lepidosaphes ulmi* L.). Comparatively little injury was noticed in the Bitter Root Valley, although occasional trees were found so badly infested that some of the branches were dead and even the fruit itself was attacked.

BUTTERFLIES AND MOTHS (LEPIDOPTERA)

Pale Western Cutworm (*Porosagrotis orthogonia* Morr.). See page 11.

Other Cutworms. *Euxoa ochrogaster* Gn., the red-backed cutworm, caused a small amount of damage in Lewis and Clark County in late June. *Euxoa tristisella* Morr. occurred early in the season in March and April, feeding on Russian thistle in northern Montana. Moths of *Euxoa pallipennis* Sm. occurred in great numbers along with moths of *Porosagrotis orthogonia* Morr. in August and September. No food plants of *Euxoa pallipennis* were determined as no larvae were collected. *Noctua clandestina* Harris, which is believed to feed mostly

on garden truck and some grasses, occurred in unprecedented abundance over a large part of the State, and the moths themselves, along with those of *Chorizagrotis auxiliaris* Grote, became the source of much annoyance in many localities. *Agrotis havilae* Grb. and *Agrotis-e-nigrum* L. were collected along with *Chorizagrotis auxiliaris* on April 20th as part of a large army of cutworms marching across prairie land in the vicinity of Clarkston.

Red-Humped Apple Caterpillar (*Schizura concinna* A. & S.). The larvae of this species caused some damage to the foliage of apple during the latter part of July and first part of August in the vicinity of Kalispell.

Sugar-Beet Webworm (*Lorostegia sticticalis* L.). Although many reports were received relative to the overwintering of immense numbers of this insect, especially throughout the more northern sections of the State, it is not believed to have been nearly as abundant over the State as a whole as during the past two or three years.

Imported Cabbage Worm (*Pontia rapae* L.). The common "cabbage worm" was responsible for much more than the average amount of damage and in some instances repeated sprayings failed to give satisfactory control.

Poplar Sphinx Moth (*Marumba modesta* Harris). Many specimens of this moth came to the laboratory.

Green Fruit Worm (*Xylina*). Injury to the fruit by this green caterpillar was noticed in many of the apple orchards of the Bitter Root Valley, in some cases being of sufficient importance to warrant control measures.

Codling Moth (*Carpocapsa pomonella* L.). This important fruit pest has been found to occur throughout practically the entire Bitter Root Valley. According to Dr. W. S. Regan, fruit pest control specialist for the Montana Experiment Station, the long period during which the developing fruit is exposed to the newly hatched larvae in the warmer, drier climates probably explains the more serious nature of the infestations in the vicinity of Missoula than farther up the valley.

Bud Moth (*Tmetocera ocellana* Schif.). Injury to the opening fruit buds in the spring, which reduces in a large measure the setting of the fruit, and the feeding cavities in the fruit itself, caused by the small brownish caterpillars, are responsible for the rather important rating as a fruit pest which this insect generally receives. Practically

every orchard visited in the Bitter Root Valley showed evidence of the presence of this pest, although there were few instances where the injury appeared to be of sufficient importance to warrant the use of special control measures.

Oblique-Banded Leaf-Roller (*Archips rosaceana* Harris). Moths of this species were observed on July 9th in sufficient numbers to be independently responsible for considerable injury, i. e., aside from injury caused by the fruit-tree leaf-roller (*Archips argyrospila* Walker).

Fruit-Tree Leaf-Roller (*Archips argyrospila* Walker). See page 16.

Fall Webworm (*Hyphantria cunea* Drury). The large, conspicuous tents of this insect were in evidence on apple trees during the early part of August in the Bitter Root Valley, being especially numerous in some of the orchards on the east side.

FLIES (DIPTERA)

Western Wheat Stem Maggot (*Hylemyia cerealis* Gillette). Damage to fall and spring wheat by this insect through Hill, Chouteau, Cascade, and Stillwater counties was very much more severe than for any year since 1918 and many thousands of acres were either a total loss or had to be reseeded.

Cherry Maggot (*Rhagoletis cingulata* Loew.) and (*R. fausta* O. S.). During the latter part of July cherries in an orchard on the east side of the Bitter Root Valley were reported to be badly infested with cherry maggot.

Greater Wheat Stem Maggot (*Meromyza americana* Fitch). A small amount of damage caused by this insect was reported from Dawson County.

Flesh Flies (*Sarcophaga kellyi* Aldrich). In a few sections of the State where grasshopper outbreaks occurred and these parasitic flies were aided by an extensive and timely use of poisoned bran mash, they increased to such numbers that by the end of the season it was evident that little grasshopper trouble need be feared in 1922.

March Flies (*Bibio* sp. and *Bibio albipennis* Say). Larvae of March flies found in garden soil, beneath boards and rocks on the ground, and the adults clustered on the foliage of currant and gooseberry bushes, caused many inquiries to be made as to their possible destructiveness.

Bee Fly Larvae (*Bombyliidae*). Bee fly larvae were found to be fairly abundant in many districts in the egg-beds of grasshoppers, especially those of the warrior grasshopper (*Cannula pellucida* Seudd.).

A Sunflower Maggot (*Straussia longipennis* Wied.). This maggot was found infesting 80 per cent or more of the Giant Russian sunflowers grown on the college farm at Bozeman and was present also in other parts of the Gallatin Valley. Although the percentage of plants infested was high, the actual decrease in tonnage was small. The maggots bore through the pith for almost the entire length of the stalk, then leave the plant by boring their way to the outside some few inches below the head, fall to the ground and there pupate about the roots, remaining in the pupa stage over the winter.

Currant Fruit Fly (*Epochra canadensis* Loew.). This chief pest of the currant in Montana continues to exact its annual toll of damage to the currant crop.

BEETLES (COLEOPTERA)

Fiery Ground Beetle (*Calosoma calidum* Fab.). This beetle with its grub which has been called the "cutworm lion" has become more abundant in northern Montana where it is one of the chief predators of the pale western cutworm (*Porosagrotis orthogonia* Morr.).

Granary Weevils (*Calendra granaria* L.). Only two infestations of the granary weevil have come to our attention and this insect is not believed to be widespread or the cause of much serious damage in the State. *Laemophloeus pusillus* Schon was found along with *Calendra granaria* L. but in much smaller numbers. (See page 17.)

Aphodian Dung Beetle (*Aphodius inquinatus* Hbst.). Many specimens of this insect in the larval stage came to the laboratory for determination as it was thought to be causing damage to crops. Adults of this species were reported in May, 1920, to have fed on seeded wheat in Chouteau County but there was no evidence whatever to show that the larvae were the cause of any damage.

Cottonwood Leaf-Miner (*Zeugophora scutellaris* Suff.). Cottonwoods suffered severely from this insect during August and September.

Wireworms (*Elateridae*). In one county in north central Montana wireworms were reported to have caused a loss of \$30,000, mostly on winter wheat. It was also declared that summer fallowed fields suffered the most. The finding of more adequate control measures for this pest has become very important to the grain interests of the State.

A Melon Pest (*Prionus* sp.). Larvae of a *Prionus* beetle caused more or less serious damage by attacking the roots of watermelon vines in Roosevelt County.

Flea Beetles (*Epitrix subcrinita* Lee., *Phyllotreta albionica* Lee., *Psylloides punctulata* Melsh., *Disonycha triangularis* Say). Various species of flea beetles caused considerable early damage to garden truck generally over the State during the past season.

Blister Beetles (*Epicauta maculata* Say and *Lytta nutalli* Say). These two species of blister beetles were especially abundant, accounted for by the abundance of grasshopper eggs on which their young develop. The adults themselves are often injurious to alfalfa and garden truck.

Plum Curculio (*Conotrachelus nenuphar* Herbst). A few apples brought in from an orchard near Hamilton at picking time showed the typical scar injury of the plum curculio. As these were the only apples seen which showed this injury, it is probable that this insect has not yet become widely established in the Bitter Root Valley.

A New Strawberry Pest (*Baris carbonaria* Blatchley). Mention was made in the State Entomologist's report for last year of an insect which caused serious damage by boring in the crowns of young strawberry plants. Several larvae feeding within the crowns were reared to adults and the above determination on a single specimen was made by Mr. C. W. Leng who states that there is no former report of this genus attacking strawberry. (Some doubt as to the exact species is entertained until more specimens are examined.)

BEES, WASPS, ETC. (HYMENOPTERA)

Yellow Jackets (Vespidae). These insects were reported to have caused some loss to one individual by feeding on raspberries.

Thread-Waisted Wasps (*Sphex communis* Cress.). Large numbers of these insects found clustered on wheat heads during the first few days in July were sent to us from widely separated sections of the State.

INSECT PESTS OF 1922

MITES AND TICKS (ACARINA)

Pear-Leaf Blister-Mite (*Eriophyes pyri* Pgst.) On account of a more general use of control measures against this pest in 1922 much less damage occurred than in the previous year.

GRASSHOPPERS, CRICKETS (ORTHOPTERA)

Mormon Cricket (*Anabrus simplex* Hald.). A great increase in the abundance of the Mormon cricket was noted this season. Large swarms occurred in Sanders and Flathead counties in western Montana and Judith Basin County and other localities through the central part of the State. The damage caused to alfalfa was small and no damage to grain crops was reported.

Warrior Grasshopper (*Catantops pellucida* Scudder). This species was again the chief one concerned in western Montana and through some counties just east of the Rocky Mountains. (See discussion on grasshoppers, page 3.)

Bruner's Grasshopper (*Melanoplus bruneri* Scudder). Damage to grain by this species in the Shield's River Valley, Park County, occurred this season. This is the first record of injury by *M. bruneri* in this State.

Two-Striped Grasshopper (*Melanoplus bivittatus* Say). The two-striped grasshopper showed a great increase, especially along the Yellowstone River during the past season.

TRUE BUGS, PLANT LICE, ETC. (HEMIPTERA)

Cabbage Aphid (*Brevicoryne brassicae* L.). This insect which was very injurious in 1921 was even more troublesome during the past season.

Green Apple Aphid (*Aphis pomi* DeGeer). In some orchards on the east side of the Bitter Root Valley this aphid was rather prevalent and caused some damage.

Pea Aphid (*Illinoia pisi* Kalt.). During the last of May and the early part of June serious outbreaks of this pest attacking alfalfa occurred near Park City and Laurel in Yellowstone County. Large acreages were infested to such an extent that heavy losses seemed inevitable. Within but a few days of the discovery of the infestations the plants were very much wilted and little hope of their recovery was entertained. However, the larvae and adults of four species of ladybugs became sufficiently abundant to wipe out the aphid infestations within a few days and cut down the loss to the alfalfa to a small part of what was expected. The ladybugs concerned were *Coccinella transversoguttata* Fald., *Hippodamia convergens* Guer., *Hippodamia 5-signata* Kirby, and *Hippodamia parenthesis* Say.

Oyster-Shell Scale (*Lepidosaphes ulmi* L.). This scale is an ever-present enemy of the fruit grower in western Montana, especially near Missoula and Grantsdale. In the case of crabapples, a very high percentage of the fruit is attacked.

BUTTERFLIES, MOTHS (LEPIDOPTERA)

Pale Western Cutworm (*Porosagrotis orthogonia* Morr.). The past season saw the first large decrease in the abundance of this pest since it came into such prominence as a grain pest in 1919. (See discussion on the pale western cutworm, page 11.)

Army Cutworm (*Chorizagrotis auxiliaris* Grote). Some few fields of grain in the north central part of the State suffered attack by this cutworm.

Euxoa pallipennis Smith. In the past two or three years during the time that traps have been set for the moths of the pale western cutworm (*Porosagrotis orthogonia* Morr.) the moths of *Euxoa pallipennis* have been caught in enormous numbers. None of the host plants, however, on which the larvae of this species develop were known until this year when great numbers of them were found feeding on Russian thistle, (*Salsola pestifer* A. Nels.). As this is the most common weed in northern Montana it is not surprising that *E. pallipennis* has been so abundant. As none of this species has been reared from the great numbers of cutworms collected in grain it is doubtful if it ever feeds on any of our grain crops.

Army Worm (*Cirphis unipuncta* Haw.). A few larvae of this species were sent to the laboratory on September 6th from Waterloo, Montana.

Striped Morning Sphinx (*Celerio lineata* Fab.). This insect was exceptionally abundant during the past season.

Achemon Sphinx (*Pholus achemon* Drury). The larvae of this insect feeding on vines, and especially Virginia creeper, were troublesome in towns along the Yellowstone River.

Imported Cabbage Worm (*Pontia rapae* L.). This pest was again very abundant and caused much loss to the cabbage crop.

Five-Spotted Hawk Moth (*Protoparce quinquemaculatus* Haw.). A pupa of this species found in the soil near a hill of potatoes at Vanada was received in the laboratory in October.

Fruit-Tree Leaf-Roller (*Archips argyrospila* Walker). See page 16.

Coddling Moth (*Carpocapsa pomonella* L.). Bud Moth (*Tmeto-*

cera ocellana Schif.). Both the codling moth and the bud moth caused noteworthy damage in the Bitter Root Valley.

Western Tent Caterpillar (*Malacosoma fragilis* Stretch) feeding on wild rose, and the Forest Tent Caterpillar (*Malacosoma disstria* Hubner) on poplar, apple, and wild rose, were very plentiful during the past summer.

Thistle Butterfly (*Vanessa cardui* L.). Great numbers of the larvae of this butterfly were observed feeding on Canada thistle (*Carduus arvensis* L.) in western Montana. No damage to cultivated sunflowers was reported.

FLIES (DIPTERA)

Warble Fly (*Hypoderma* sp.). Two partially grown larvae of Hypoderma were expressed from under the skin of a child five years old at Dixon. One came from a swollen congested area immediately anterior to the orifice of the left ear, the other from vertex of skull.

Sunflower Maggot (*Straussia longipennis* Wied.). This maggot was again present in a large percentage of the sunflower plants on the college farm.

Currant Fruit Fly (*Epochra canadensis* Loew.). The currant fruit fly was especially injurious in the western part of the State.

BEETLES (COLEOPTERA)

Fiery Hunter (*Calosoma calidum* Fab.). Although in the northern part of the State, through the country infested with the pale western cutworm, there was last year a fair abundance of this beetle, during 1922 it was noticeably scarce.

Flea Beetles. The species of flea beetles given in Insect Pests of 1921 were again very injurious this season.

Alder Flea Beetle (*Haltica bimarginata* Say). This insect occurred in great numbers at Glasgow, Valley County, and Glendive, Dawson County.

Blister Beetles (*Epicauta maculata* Say and *Lytta nuttalli* Say). These two blister beetles were very abundant over the entire State and caused much damage in farm gardens. Some damage by them to alfalfa was reported.

Wireworms (*Elateridae*). Considerable damage to the potato crop in some eastern counties as well as in the western counties of Sanders, Flathead, and Missoula was done by wireworms.

BEES, WASPS (HYMENOPTERA)

Ants (*Formicidae*). Many requests were received for information on the control of ants in wheat fields. The usual number of complaints regarding house ants were also received.

Pine Sawfly. A sawfly occurring in enormous numbers through the pine belt in southeastern Montana did a great amount of damage by completely stripping the needles from the trees attacked. The period of greatest feeding was during the month of July and the first part of August.

RECOMMENDATIONS

There can be no doubt that the actual saving of crops from grasshoppers in Montana in 1922 was well over two and a half millions of dollars. This work centers in the State Entomologist's office which co-operates with the county agents in counties where there are such agents and with county officers where there are no agents. Grasshoppers are the main insect pest at the present time but our activities are by no means confined to fighting these insects. There are many pests of somewhat lesser importance. Each season differs in its demands and we are compelled to maintain an office and laboratory system prepared to meet any situation that may arise. The basis of the work is technical information which we ourselves must gather. The work is actively connected at all times with that of the Experiment Station which maintains a separate staff.

The work of the State Entomologist's office is maintained on an appropriation of \$3,900—a sum ridiculously small when compared with what is accomplished with it. One man only, the Assistant State Entomologist, Mr. A. L. Strand, is employed under this fund. The State Entomologist receives no salary as such. Mr. Strand's salary and all of his expenses, as well as any student assistance, supplies and sundries, must be paid for from this \$3,900. In many instances during recent years it has been necessary to refuse his services to different counties and communities when his presence would have undoubtedly resulted both in much saving of crops and in a more satisfactory return in taxes to the county and State treasuries. It can be easily demonstrated from our records that information originating in this office has repeatedly resulted in the saving to the State in a single day many times over the entire annual appropriation for this work. In recent years we have been able to attend only to the most insistent emergency

matters. We know that much damage is being done to the principal crops of the State by other insects and we are unable to give them any attention whatever. Almost no attention has been paid to the alfalfa weevil during the past three years. It may be, and very likely is, present unrecognized in some part of Montana at this time. It is very unwise to neglect to survey the State for the alfalfa weevil and other pests of like character. There have been times when the Assistant State Entomologist, with time available, has remained in the office because there was no money for traveling expenses.

The time has come when another assistant must be employed in this work. It is recognized that the condition of the State treasury does not warrant branching out into new expenditures, but this is not the place to economize. Under present conditions, instead of taking an aggressive attitude toward the pest situation we are compelled to do the best we can in meeting emergencies only and explain to farmers and county officials that we have no funds.

Without hesitation and in full knowledge of the condition of the State treasury, I urge that increased funds be made available to this office.

Following is the budget of estimated expenses as it has been submitted through the proper channels:

	1923-24	1924-25
Office assistance	\$ 150	\$ 150
Assistant State Entomologist	2,700	2,700
Second assistant	2,000	2,000
Labor	200	200
Other employees (temporary assistance—May, June, July)	450	450
Sundry office supplies	40	40
Telephone and telegraph	100	100
Express, freight and drayage	15	15
Traveling expense	1,450	1,450
Printing and binding publications.....	50	50
Poisons and chemicals	40	40
Laboratory supplies	150	150
General supplies and expenses.....	15	15
Library and reference books.....	50	50
 Totals	 \$7,410	 \$7,410

